TS-SSC 90-094
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Sizing Data of DS320 Dummy Windings

The test winding of 50 mm short magnet was made most of them without end spacers. The purpose of this coil is to debug the tooling for the winding of DS321, the first 50 mm dipole magnet. The coil being wound are summarized as follows. Some of them were intentionally molded with 5-mil shim so that we can check the controllability of the coil size.

inner	1M-50-101	no shim	for DS320	
	1M-50-102	no shim	for DS320	wound opposite direction
	1M-50-103	5 mil	for cut-up	
outer	1M-50-201	no shim	for DS320	
	1M-50-202	no shim	for cut-up	reversed wedge
	1M-50-203	5 mil	sizing test	with end spacers
	1M-50-204	no shim	for DS320	with end spacers

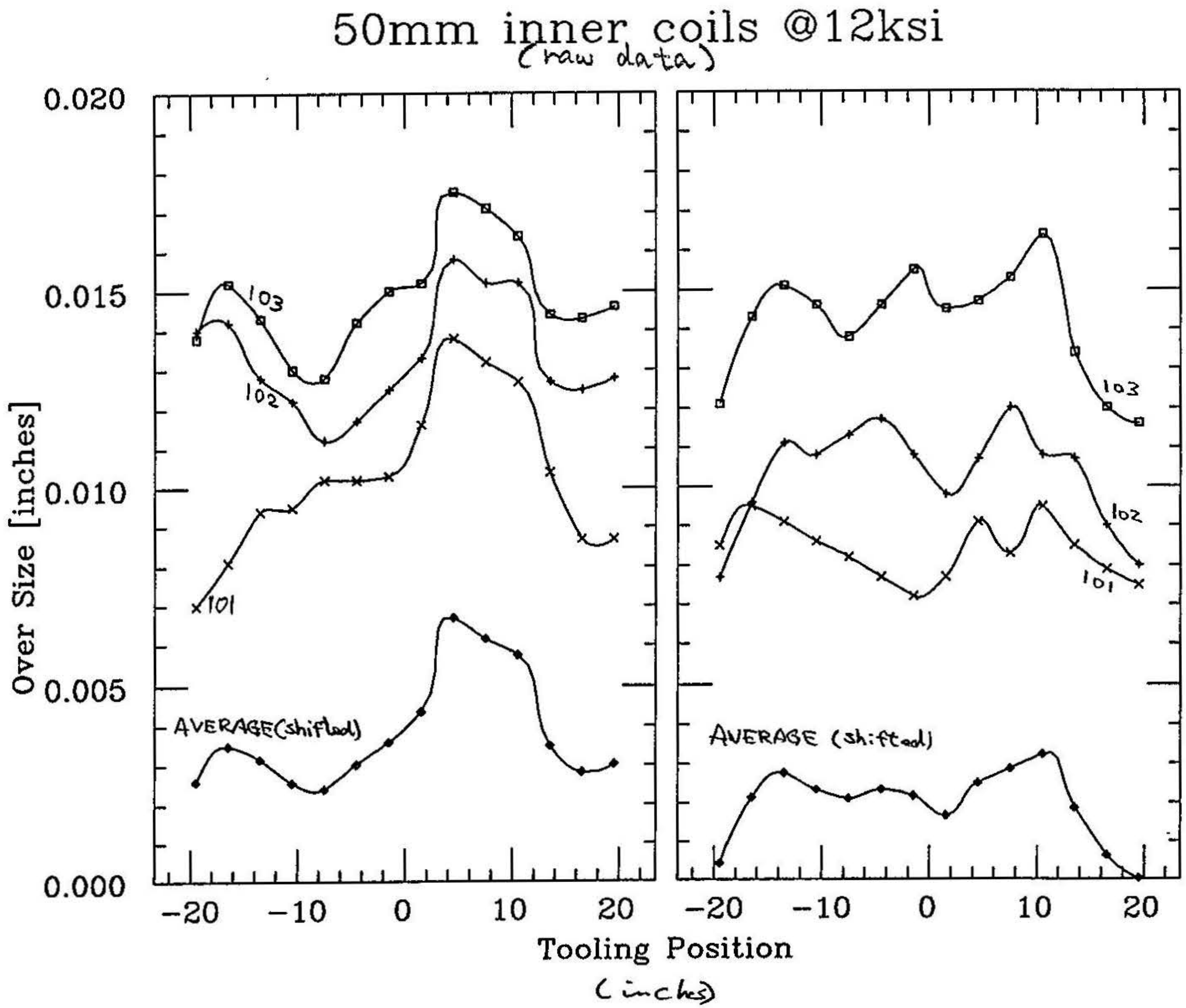
The sizing data are graphically shown in Fig.1 and Fig.2 for the inner and outer coils, respectively. The size of the coils are 10 mil larger than we had expected. Another thing is that the coil seems to have a systematic errors as well as the random error. Averaged deviation shape over these series of the coil shown in the same figure indicates the systematic error of the tooling. The source of the systematic error in the outer coils is the inaccuracy of the mandrel. Actually some of the mandrel blocks were machined after the quality assurance measurement to correct the oversize and the machining made them undersized. This relation between error shape and the tooling error was pointed out by Dick Sims. The exact source of the error in the inner coils is not known yet but the measurements of the mandrel will tell us some inaccuracy of the tooling. Even if we do not know the exact source of the error, we could have shims between holder and blocks of the mandrel to compensate the systematic errors. If we subtract this systematic error from the data, we can obtain the random error of the coil as shown in Fig.3 and Fig.4. A good improvement is expected if we make the correction to the mandrel especially for the inner coil but still there are several things to be pointed out.

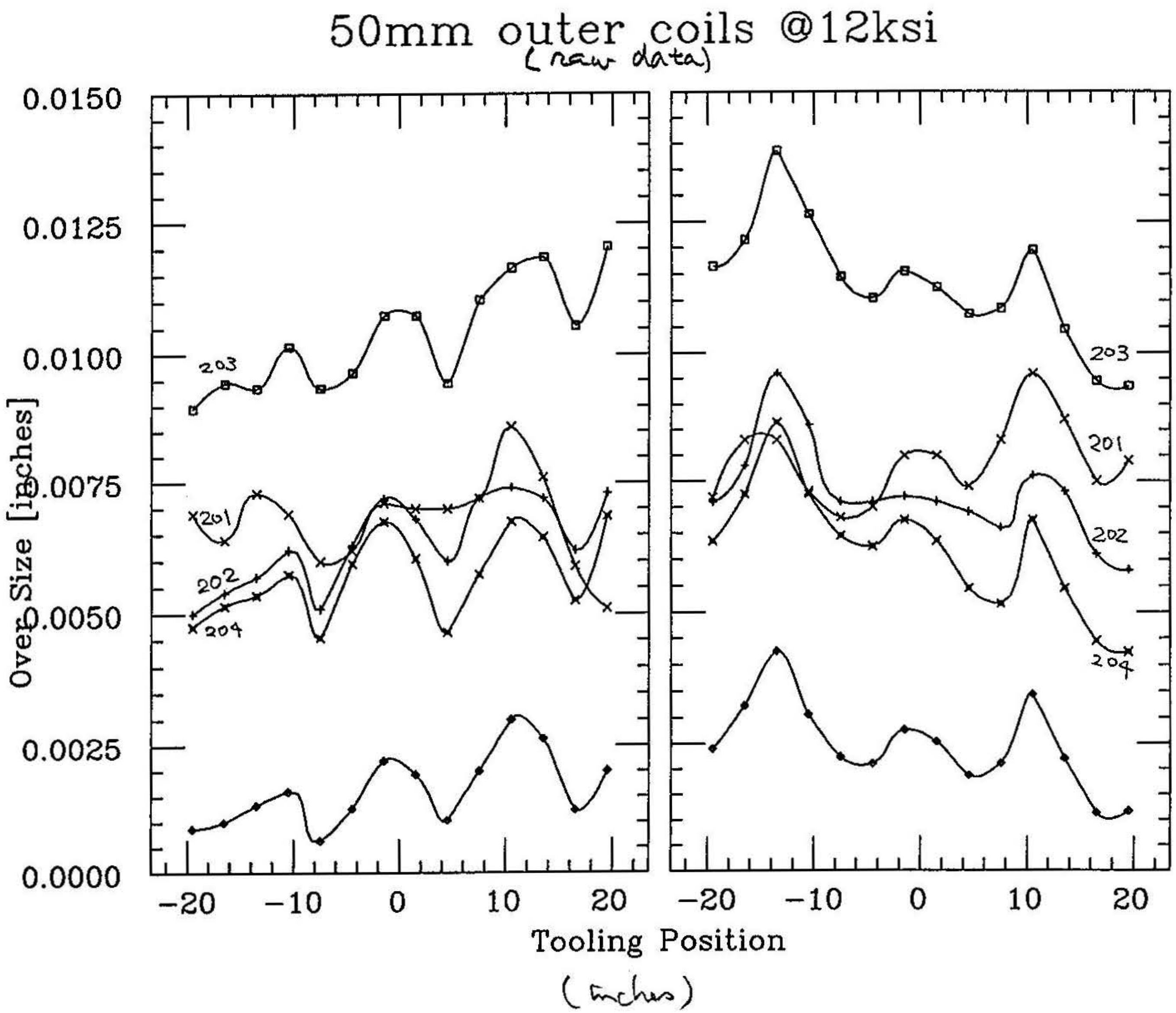
- (1) There is a large tilt in the coil size along the z-axis which appears positive or negative depending on the coil. These tiltings are not corelated with both side of the coil. Therefore, this might be caused by the motion of the center post as pointed out by Dick before.

- (2) We might be over compressing the coil during the molding because the coil size at the pressure of 12 ksi is significantly larger than what it should be. The size of the coil cured with oversize shim, which means less pressure, looks better in the size distribution. This fact also supports the suspicion against the over compression.
- (3) The required accuracy for the coil size is more strict if we take the hysteretic behavior of the coil into account. Fig.5 and Fig.6 are the pressure size relation of the coil. A large hysteresis is seen in the up-ward and down-ward of the compression. Since the direction of pressure loss happens in the down-ward, a slight loosening due to the spring back of the collar or the thermal shrinkage of the coil will cause a large pressure loss. The doted lines in Fig.5 and Fig.6 indicate the reference data to subtract the deformation of the sizing fixture from the raw data shown by dashed lines.

For the long magnet, neither measurement nor correction of the tooling are not easy thing to do. Probably, a kind of feed back loop of siming by the measurement data of coils my be the way we should do.

Fig 1


50mm inner coils @12ksi
(raw data)
0.020
0.015
0.010
0.005
0.000
Over Size [inches]
103
102
101
AVERAGE(shifted)
AVERAGE (shifted)
-20
-10
0
10
20
Tooling Position
(inches)

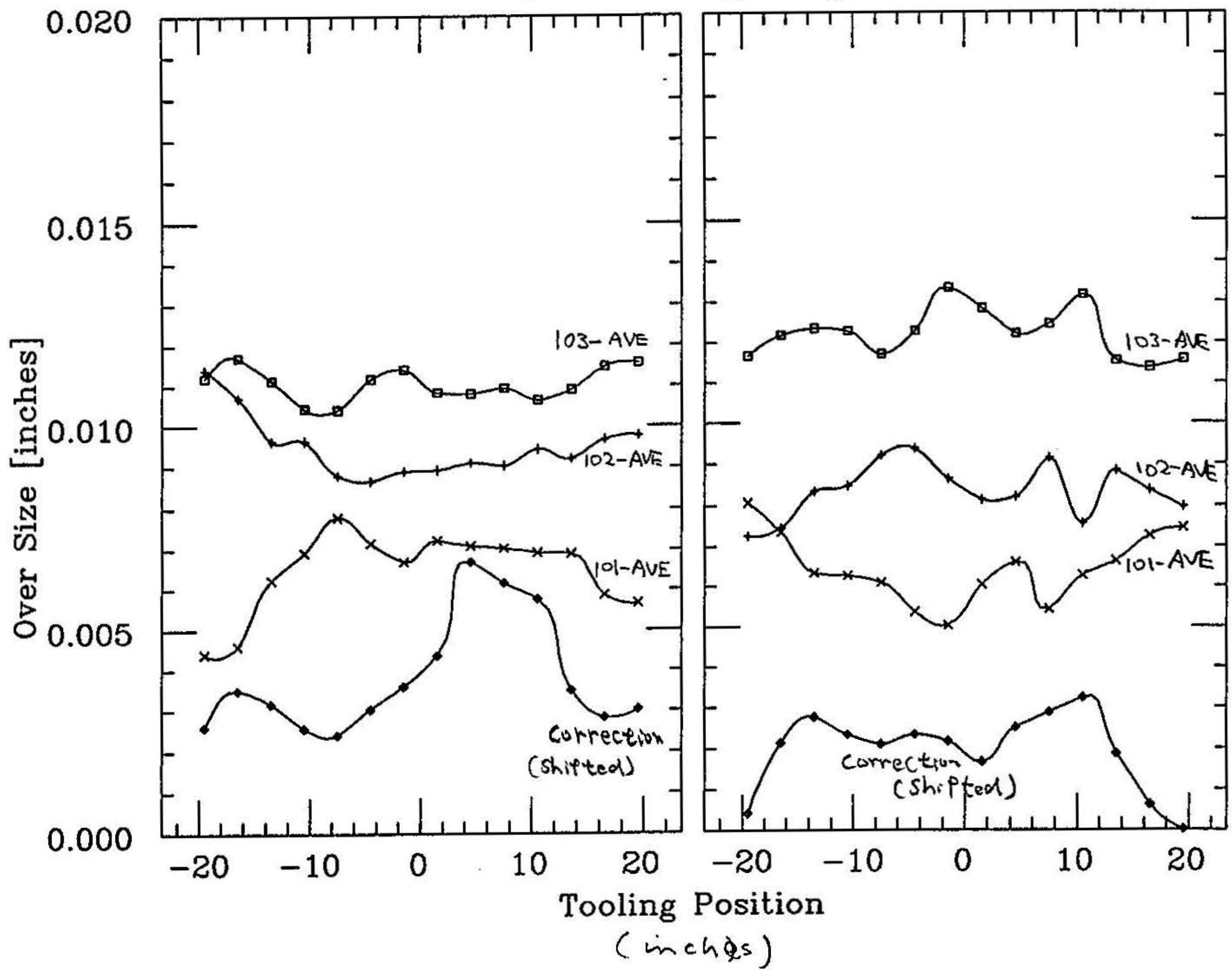

50mm outer coils @12ksi
(raw data)
Over Size [inches]
Tooling Position
(inches)
203
201
202
204
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
−20
−10
0
10
20

4

Fig. 2

Fig 3

50mm inner coils @12ksi
(random error)



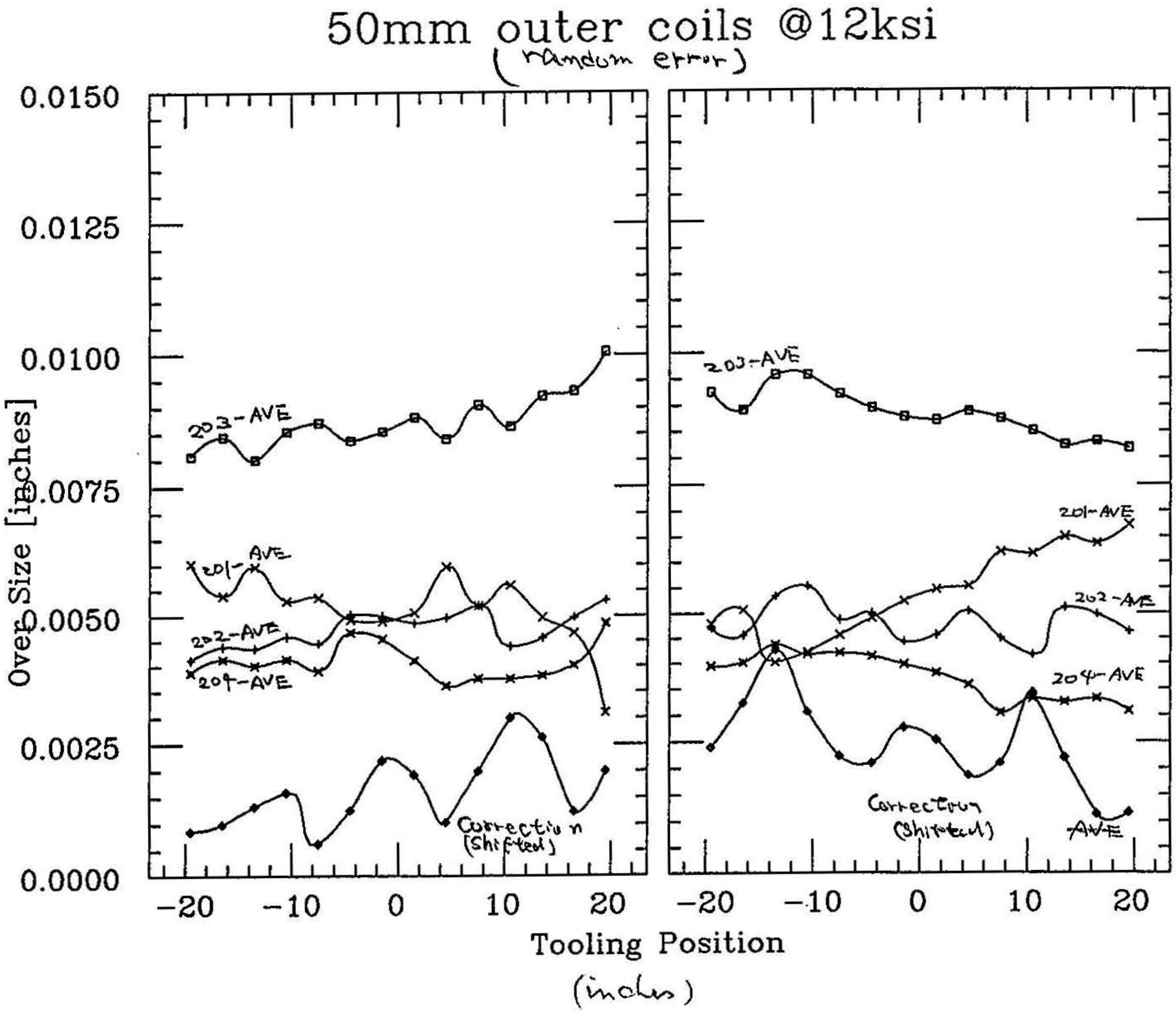

50mm outer coils @12ksi
(random error)
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
Over Size [inches]
203-AVE
201-AVE
202-AVE
204-AVE
Correction (shifted)
203-AVE
201-AVE
202-AVE
204-AVE
Correction (shifted)
AVE
-20
-10
0
10
20
Tooling Position
(inches)

Fig 4

9

Fig 5

50mm inner coil--1M501X2

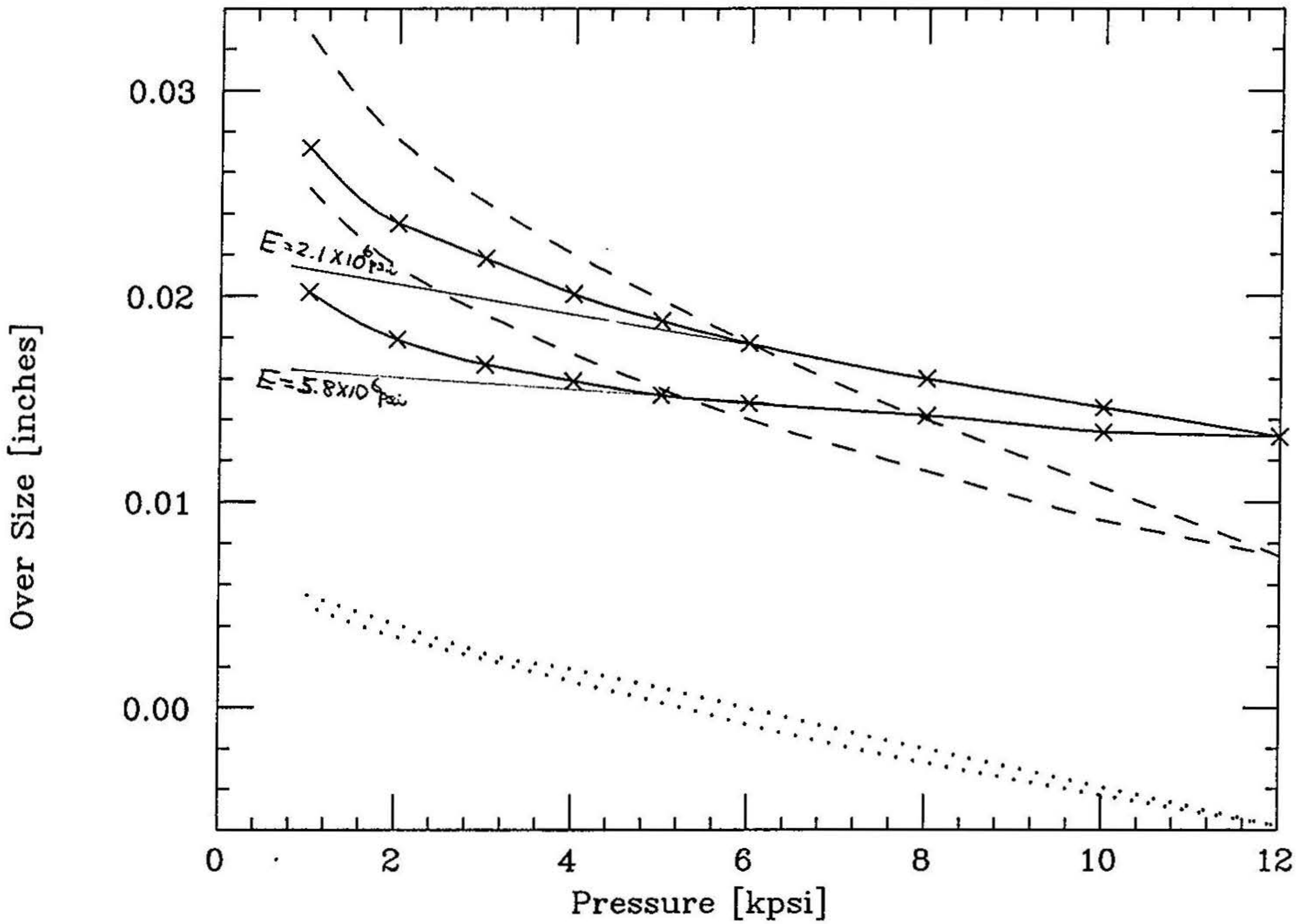
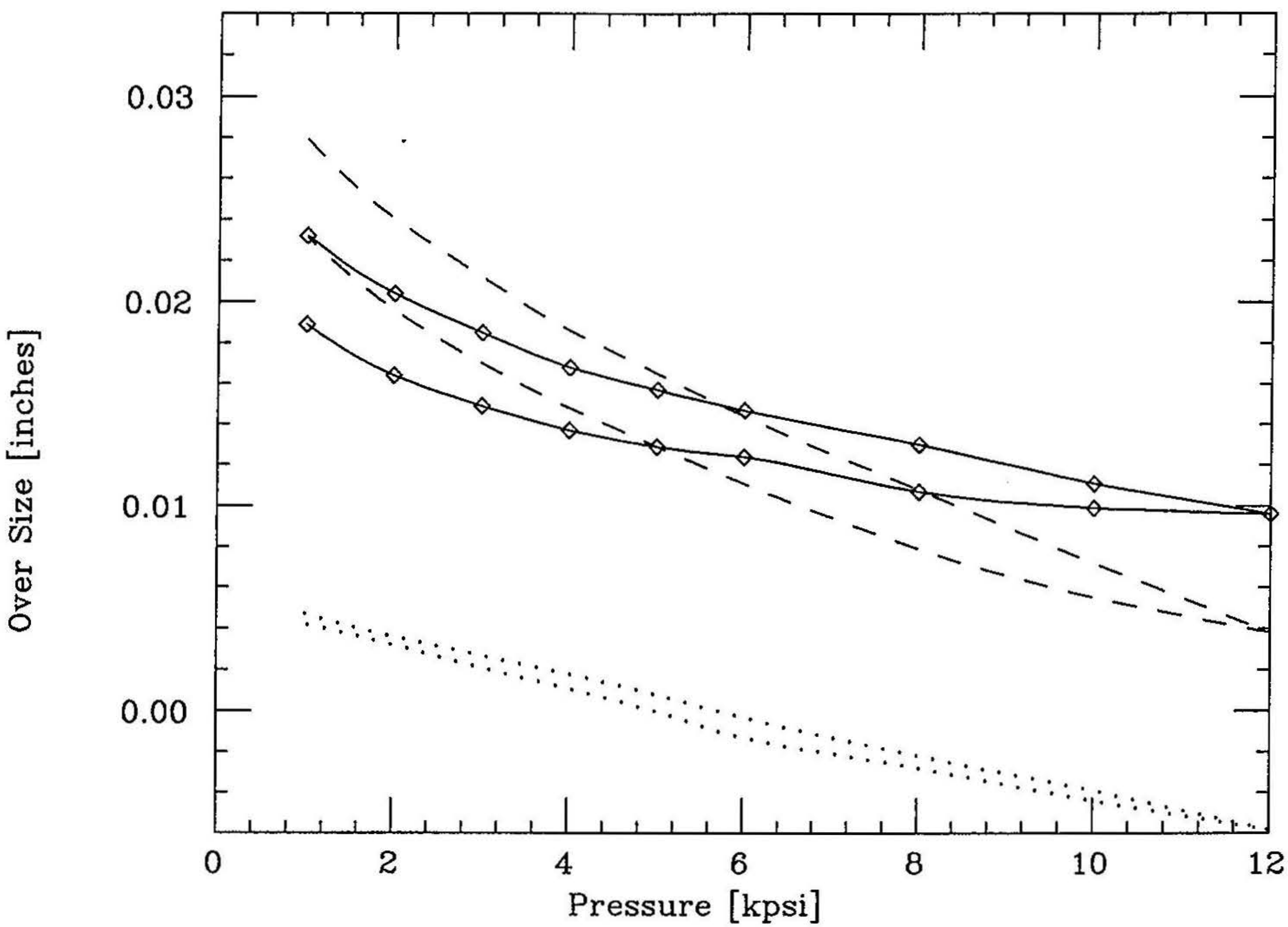


Fig. 6

50mm outer coil--1M50_2X3



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